



Paralleling Capability of SynQor[®] Rack Mount System Products

Application Note

Summary

This application note provides an overview of the paralleling capabilities of the SynQor Rack Mount System Products.

Introduction

SynQor rack mount system products can include an optional feature that allows combining the units to build complex systems. The units with this built-in functionality can synchronize their outputs to deliver higher power through paralleling for split-phase or 3-phase multiple unit configurations. Some of these products have multiple output ports that can be paralleled. This application note includes a quick reference summary table that describes the paralleling capabilities and the paralleling algorithms used for the output ports available on rack mount system products with built-in paralleling features. Note that some systems may have different types of paralleling capabilities for their output ports. For example, some rack mount system products may have AC output or DC output or both AC and a number of DC output ports. AC ports use a digital load sharing method while some parallelable DC output ports may use the droop method and some the digital method. The DC1 output ports in rack mount system products do not current share and should not be interconnected.

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Description of paralleling algorithms:

I - AC Output Current Share (“-F” and “-R” type units only):

The rack mount system products support two different paralleling schemes for the AC output: standard paralleling “-F” and expanded paralleling or redundant paralleling “-R”. Only floating neutral “F” or “R” option system products can be paralleled to deliver higher power in different system configurations, like single-phase, split-phase or 3-phase output. The “G” type option system products have their output neutral internally connected to ground and must not be used in parallel application to avoid neutral currents from being able to flow in the ground connections of the paralleled system products. The system products will only parallel with the floating neutral “F” or “R” option to prevent any neutral currents from being able to flow in ground connections. If a parallel system consisting of floating -F or -R units must be grounded, then the ground connection can be made externally.

To parallel the AC or DC output ports of multiple rackmount system products, the units must be of the same model, power rating and type. The paralleling algorithm does not support paralleling of units whose models, power rating, output voltage, output frequency and types differ. For example, to parallel the AC port output of a set of UPS-1500-S-1U units, they must all be of the same type “-F” or “-R”, they must have the same output voltage and the same output frequency. Paralleling of UPS-1500 units with UPS-3000 units is not allowed.

AC output port paralleling implementation uses a master-slave digital current sharing algorithm. In this paralleling algorithm, the master broadcasts its output current reference and phase angle, the backup and slave units then try to deliver the same amount of current as the master at the intended phase angle. Typically, the master/slave roles are defined when the units exchange information when they are first powered “ON”. A series of handshaking messages are exchanged during startup, the units elect a master for the group from the available units. They also elect the backup master unit. If the master becomes unavailable, the backup unit will then assume the responsibilities of the master without the system output shutting down, assuming that the remaining units can still deliver the required amount of power to the load. When a backup unit assumes the role of a master, a new backup unit is also elected from the remaining operational units. If a slave unit fails, the system will continue to power the load, assuming the remaining units can still supply the required power.

The digital load sharing method used by the AC output ports, allows not only for the creation of single-phase paralleled output systems, but complex output configurations as well, like split-phase (two units) and 3-phase output system (multiples of 3 units) by using an appropriate configuration cable. In a split phase system, the two outputs are 180 degrees out of phase. In three-phase output systems the relative phase angles of the three output voltage waveforms are shifted 120 degrees apart. The phase rotation of the three-phase configured units is determined by the connectors of configuration cable connected to the units. Redundancy in these complex systems can be achieved by using “R” type units and adding additional units to each phase group.

The power up and shutdown behavior of paralleled “F” option UPS and MPC 1500 and 3000 units differ from the rest of rack mount SynQor system products as explained below.

- Paralleled UPS and MPC 1500 and 3000 units:
 - During startup, all paralleled “-F” type units must be individually enabled through the front switch, or RS-232 port, or Web interface, or SNMP interface or digital I/O before the output for the entire system is enabled. However, if any one unit shuts down its output for any reason, the rest of the units in the paralleled group will also shut down their outputs. Up to 3 units can be paralleled in a single phase configuration, two unit set in a split phase configuration or three units can be connected in a 3-phase output configuration.
 - Enabling the output of any one the paralleled “R” units by any method, will automatically enable the outputs of all the paralleled units connected to an input power source. However, shutting down any one unit in the group will only shut down the output of that particular unit, assuming the remaining units are able to sustain the load. The output of an entire group can be disabled by issuing the “SYSTEM DISABLE” command through the serial port. Up to 32 units can be paralleled, connected in single phase, split-phase (multiples of 2 units) or in a 3-phase output configuration (multiples of 3 units). Expanded paralleling or redundant “-R” type units include an electronic switch which disengages the output of a unit in case of failure.

- Paralleled MAC and MINV 4000 units:

The power up and shutdown behaviors of both “-F” and “-R” units are identical. Enabling the output of any one of these units in a group by any method, will automatically enable the output ports of all the units in the group connected to an input power source. However, shutting down any one unit in the group will only shut down the output of that particular unit, assuming the remaining units are able to sustain the load. The output of an entire group can be disabled by issuing the “SYSTEM DISABLE” command through the serial port. Up to 32 units can be paralleled, connected in single phase, split-phase (multiples of 2 units) or in a 3-phase output configuration (multiples of 3 units). The difference between “-F” standard type units and “-R” redundant type units is that the “-R” type units include an electronic switch that disengages the output of a unit in case of a failure

II – DC Output Current-Share:

DC output current sharing in SynQor system products is accomplished by either the droop method or the digital share method as shown in the table below.

Droop Method: The droop load share method is very scalable and requires no active communication among the units. The output voltage of the droop share units droops as output current increases. At lighter loads, the output voltage is higher and at heavier loads it is lower. This is graphically represented as output voltage vs. output current, known as a load-line, and it slopes downward as current is increased. System products connected in parallel using the droop share method will share the current in accordance with how well their load-lines are matched and also how well the external output impedances between the converters and the common connected points are matched. You can find the load-line graph in the datasheet of the system products.

Digital Method: Units designed for the digital current-share method broadcast their output voltage and current information digitally to all the units connected in parallel. Each unit then tries to regulate to the estimated average output voltage and current individually. The paralleled system products must use an appropriate configuration cable from SynQor, please refer to the datasheet for details. Units communicate with each other via a digital bus through the configuration cable. Each unit must be connected to one of the connectors of this configuration cable.

Quick Reference Guide to Paralleling Capabilities of SynQor Rack Mount System Products

SynQor System Product Family	Input Power	Output Power	Built-In Paralleling Capability (AC Output)	Built-In Paralleling Capability (DC Output)
MPC				
MPC-1250-1S	1-Phase AC & DC	DC	N/A	Yes, for Regulation Type 'P' (Digital Method) No, all others
MPC-1500-1U MPC-1500-1S MPC-3000-2U	1-Phase AC	1-Phase AC & DC	Yes, for F and R (Neutral Wire Options) No, all others	Yes, DC2 output with Droop Share Option No, for DC1 output
MPS				
MPS-4000-1U	3-Phase Δ AC	DC	N/A	Yes, Droop Method
MPPS-4000-1U	3-Phase Δ AC	DC	N/A	Yes, Digital Method
MINV				
MINV-4000-1U-28 MINV-4000-1U-270	DC	1-Phase AC	Yes, for F and R (Neutral Wire Options) No, all others	N/A
MAC				
MAC-4000-1U	3-Phase Δ AC	1-Phase AC	Yes, for F and R (Neutral Wire Options) No, all others	N/A
UPS				
UPS-1250-S-1U UPS-1250-S-2S UPS-1250-E-2U	1-Phase AC	DC	N/A	Yes, for Regulation Type 'P' (Digital Method) No, all others
UPS-1250-S-1U-270 UPS-1250-E-2U-270	1-Phase AC & DC	DC	N/A	Yes, DC3 output (Digital Method) Yes, for DC2 output 'M' and 'R' options only (Droop Method). No, all others No, for DC1 output
UPS-MS-1500-S-2U	1-Phase AC	1-Phase AC	No, only G Neutral Wire Option Available	N/A
UPS-1500-S-1U UPS-1500-S-2S UPS-1500-E-2U UPS-3000-S-2U	1-Phase AC & DC	1-Phase AC & DC	Yes, for F and R (Neutral Wire Options) No, all others	Yes, for DC2 output 'M', 'R' and 'Y' options only (Droop Method). No, all others No, for DC1 output
UPS-1500-S-1U-T UPS-1500-E-2U-T	3-Phase Δ AC	1-Phase AC	Yes, for F and R (Neutral Wire Options) No, all others	Yes, for DC2 output 'M', 'R' and 'Y' options only (Droop Method). No, all others No, for DC1 output
EBM				
EBM-1000-2U-28-3000			N/A	Yes

Note: This chart is intended as a quick reference guide to the paralleling capabilities of SynQor system products

Please feel free to contact SynQor technical support for further assistance when paralleling any specific SynQor system product.